

coke ovens. Our "perversity" in preferring hard to soft coke is condemned, and we are invited to put reason in the room of traditions which have not "one recorded fact to sustain them."

My attention, as an iron-smelter, was drawn to the very small consumption of charcoal in a certain instance quoted by Prof. Tunner, of Leoben, and being unable to reconcile his experience with my own observations, I obtained from this respected authority further confirmation of the exactness of his figures. Along with this he kindly repeated his analyses, including one not given in his original paper, viz., that of the gases taken on leaving the furnace, in other words, after they had *completed* their work.

Other investigations prevented my examining the question at the time with that attention it deserved, and I concluded, upon other grounds than those advanced by Prof. Church, that there was some actual difference in the mode in which charcoal effected the reduction of at least *some* ores.

In this I now think that I was mistaken, and I will endeavour to prove that the author of the paper commits a grave error in comparing two blast-furnaces working upon different kinds and quantities of ores and flux used in the production of pig-iron. I will also attempt to demonstrate that the use of hard coke, held to with such "singular perversity," can be maintained by "reason" as well as by "tradition."

Carbonic oxide, as is well understood, is the chief reducing agent in the smelting of iron, and for our present purpose we may regard it as the only substance which deprives the metal, as it exists in ores, of its oxygen. The carbonic acid which is formed by this deoxidising action possesses a tendency, at certain temperatures, diametrically opposed to that of the lower oxide of carbon—it reoxidises the iron.

This conflicting property of the carbonic acid is kept in check, in iron smelting, by the presence of carbon in the form of its lower oxide, being about double that which is present in its highest form of oxidation.

When I came to examine the ratio in which the carbon in these two conditions existed in the escaping gases, as described privately by Prof. Tunner, I observed that they agreed very nearly with that which I imagine constitutes, in furnaces using coke, a state of equilibrium between the gases and the ore in the process of reduction.

Now no one will dispute that when two pounds of carbon are burnt to the state of carbonic oxide and one pound to the form of carbonic acid the quantity of heat is the same, from whatever source the carbon itself may be derived.

If, after having determined a perfect resemblance between the extent to which the fuel has been oxidized, in the furnace, when using charcoal and using coke, we find that there is no difference in the amount of heat wasted, it is time to consider whether the pig-iron itself, obtained by means of these two kinds of fuel, may not require very different quantities of heat for its production.

It may be here stated that the Cleveland furnaces in England, with which I compared those of Carinthia, were consuming 21 to 22 cwt. of coke against 14 or 15 cwt. of charcoal used in the latter per ton of iron. The weight of the slag produced in the former was very much the larger of the two. The additional heat absorbed in fusing this substance was further augmented by that required for the decomposition of silica and phosphoric acid, the bases of which are found more largely in Cleveland than in Carinthian pig. The diminished quantity of fuel burnt in the charcoal furnaces reduces very greatly the weight of gases, and this consequently lessens the amount of heat carried away through their instrumentality.

The following figures exhibit the number of centigrade heat units required, according to my calculations, per unit of each kind of pig-iron referred to.

	Cleveland iron.	Carinthian iron.
Evaporation of water in fuel	15	15
Reduction of oxide of iron and dissociation of carbonic oxide	1730	1730
Expulsion of carbonic acid from carbonate of lime	250	25
Decomposition of this carbonic acid	265	25
" water in blast	130	75
" silica and phosphoric acid	200	50
Fusion of iron	330	330
" slag	830	330
Loss by radiation	270	200
Carried off in gases	440	210
	4460	2990

Now when the proportions between the heat requirements and fuel-consumption come to be examined, we find that the two sets of numbers agree almost exactly; for—

$$4460 : 2990 :: 21 : 14.08$$

Since writing on this question, nearly seven years ago, I have had frequent opportunities of examining the performance of charcoal-furnaces in Sweden, Italy, and Spain, as well as in Virginia, Kentucky, Ohio, Missouri, and Michigan, in the United States. I soon became aware that different kinds of ores demanded very different quantities of charcoal for their treatment. In some cases the weight was nearly as low as that consumed in Carinthia, in others it was quite as much as if coke had been the fuel employed. I failed on every occasion to detect any circumstance beyond the change in the ore itself, or in the nature of the iron it afforded, to which I could ascribe the difference in question. All doubt, however, on the supposed difference of value between the vegetable and mineral fuel was dispelled on receiving from the owners of works in the North of Spain and in Virginia, statements from their books exhibiting the smelting of the same ores with the two kinds of fuel. The difference in these was often in favour of the coke, but such difference as existed could easily be accounted for by fluctuations in the amount of foreign matter in the fuel, or in small changes in the quality of the ores.

It only remains for me briefly to mention the grounds upon which, for chemical reasons, hard coke may be superior to that softer variety recommended by Prof. Church.

Carbonic acid, as is pointed out in the paper by this author, possesses the power of dissolving carbon, and every pound so dissolved involves a double loss. There is a reduction of temperature where the action takes place, and there is a pound less of fuel remaining to be burnt at the tuyeres. I ascertained, however, by direct experiment, that all forms of carbon are not equally easily affected by carbonic acid, that in hard coke being capable of resisting the solvent action much better than the same carbon as it occurs in soft coke. The importance, therefore, of employing our fuel in that condition where it is least susceptible of being oxidized in the region of the furnace where its combustion is useless, need not be further insisted on.

I am ready to admit with Prof. Church, that the traditional opinions of practical men have often required correction from scientific investigation, but upon the present occasion, so far as I have been able to judge, the ironmaker and the chemist agree in the relative value of hard and soft coke.

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PAPUAN HERPETOLOGY¹

IN this memoir, which forms a portion of the thirteenth volume of the *Annals* of the Civic Museum of Genoa, we have by far the best account of the herpetology of

¹ "Catalogo dei Rettili e dei Batraci raccolti da O. Beccari, L. M. D'Albertis e A. A. Brujin, nella sotto-regione Austro-malese." Per W. Peters e G. Doria. *Ann. del Mus. Civico*, Genova, vol. xiii., 1878.

the great Papuan subregion, that has hitherto appeared. At the same time the authors have not attempted to make a perfect faunistic work of it. Only such species as are represented in the collections made by the Italian travellers, Beccari and D'Albertis, on their various joint and several expeditions, and in the collections sent to Genoa, by Herr Bruijn of Ternate are enumerated in the list. On the other hand the mass of these collections is so great—consisting of 3,000 examples from 44 different localities, and the series thus brought together is so much more nearly perfect than that which any other authors have had before them—that the result has been to give us an excellent idea of the general character of the reptiles and batrachians of this division of the earth's surface. Let us, therefore, look through the pages of Messrs. Peters and Doria's excellent memoir, and see what general views we can obtain from it as to the peculiarities of this little-known branch of the Papuan fauna.

In the first place, land-tortoises are few in the Papuan sub-region. Our list contains but two species, one from Amboina and Celebes, the other from the southern extremity of New Guinea, and very doubtfully distinguishable from an Australian species.

Crocodilians are also scarce. The series contained examples but of one species—*Crocodilus porosus*—which extends from India into Northern Australia.

Of lizards, besides the monitors, of which genus not less than 16 species are contained in the list, the great mass are Skinks, Geckos and Agamids. As in Australia the Skinks are especially numerous, upwards of 30 species being represented in the series, of which 8 are now described for the first time.

The ophidians are also well represented in the Papuan fauna, the series examined by our authors affording examples of 54 species. Amongst the Boas *Liasis* and *Chondropython* are characteristic Papuan forms, whilst the Australian *Morelia* also extends into New Guinea. But no greater sign of the essential unity of the Australian and Papuan faunas can be shown than the presence in New Guinea of the three Elapine genera, *Diemenia*, *Pseudechis* and *Acanthophis*, all characteristic forms of the Australian continent. At the same time the presence of an *Ophiophagus* in New Guinea, proves that an intruding element from the north has reached thus far.

About 20 batrachians close the list, amongst which *Limnodytes* and *Hyla* seem to be the most prevalent genera. The Australian *Pelodytes carolea* is abundant all through the sub-region. A new and very singular form obtained by Beccari in the interior of New Guinea, near the river Wa-Sampson is characterized as *Sphenophryne cornuta*, and a second, obtained, by the same explorer on Mount Corfak as *Xenobatrachus ophiodon*. The latter shows some points of affinity to the Australian *Myobatrachus*.

Seven excellent lithographic plates illustrate some of the rarities described in this memoir, and two maps are added to show the exact localities where the collections were found. The maps we see with great pleasure, as in our opinion no zoological work of a faunistic character can in these days be considered complete without such an appendage.

THE METEOROLOGICAL SOCIETY LECTURES

A COURSE of six lectures on meteorology was recently delivered under the auspices of the Meteorological Society at the Institution of Civil Engineers. The purpose of these lectures, we believe, is to spread a knowledge of the known facts and principles of meteorology, and in this useful mission we cannot but wish the Society every success. We here give abstracts of two of these lectures, by Mr. J. K. Laughton and the Rev. W. Clement Ley. The subject of Mr. Laughton's lecture was—

Air Temperature, its Distribution and Range

After calling attention to the importance of climatic knowledge the lecturer dwelt on the fact that though all heat as affecting climate emanates directly or indirectly from the sun, temperatures have but little relation to latitude except when the distances are very great. He illustrated this by reference to isothermal and isabnormal maps, and went on to speak in some detail of the several causes of the disagreement between isotherms and parallels of latitude. Locally there is a very great difference between the temperatures of adjacent localities on account of the sunny aspect or sheltered situation of some as compared to others, as is found in an extreme degree in such places as the Undercliff of the Isle of Wight; but geographically, a cause of very considerable importance is the nature of the soil. The air over sandy or sterile ground is heated by direct contact and by radiation, to a degree far in excess of what happens to air resting on grass-grown or verdant plains; heat proceeding from an obscure source is unable to escape through the air, just as obscure heat-rays may be caught and accumulated in a closed conservatory or in a glass-covered box, so that the air may be raised to a very high temperature: several instances are on record of a temperature of 130° F. being observed under such circumstances. On the other hand, when the solar heat falls on ground, whether grassy or snow-covered, that will not easily part with it, the air may remain cool, or even cold; as is found in our every-day experience in summer of the pleasantness of a field path as compared with a high road; and as is shown more markedly by the great power of the direct rays of the sun in the Arctic, or at elevated stations in the Alps or Himalayas, whilst the snow is lying all around, and the temperature of the air is far below freezing-point.

But greater far than the effects of differences of soil are the effects of ocean currents, which warm the air to an almost incredible degree. Mr. Croll has calculated that the surface-water of the North Atlantic, if deprived of the Gulf Stream, would be reduced to a temperature very far below freezing-point; that the heat which the Gulf Stream disperses into the superincumbent air would, if converted into power, be equal to the united force of some 400 millions of ships such as our largest ironclads. This heat, thrown into the air, is wafted by the south-westerly winds over the north-west of Europe, and very largely over our own country. It is this that makes the extreme difference between the climate on this side the Atlantic and that on the other, that gives us green fields and open harbours during the winter, whilst in Labrador or Newfoundland they are buried in snow or choked with ice.

The carrying power of water is so great as compared with that of air that the climatic effect of winds heated by contact with hot earth is relatively small. The scirocco of the Mediterranean, a wind heated over the great African desert, has often been referred to as the "snow eater" of Switzerland. This has been proved to be a mistake. The snow-eating wind of Switzerland is a wind from the Atlantic, warmed by the Gulf Stream, and rendered dry and hot by the condensation of its vapour as it passes over the mountains. Similar winds have been observed in many different parts of the world—in New Zealand, in Norway, in Greenland, and in North America, where their peculiar dryness, carrying off all moisture, renders the grass so inflammable that the smallest accidental spark lights up a fire which may spread over a country, and is thus the true cause of those immense prairies which are a distinctive feature of North American geography. But such hot winds are quite distinct from such winds as blow from the Sahara, or the Stony Desert of Australia, or from many other sterile tracts of country; winds which are merely the escape of air heated to an extreme degree by contact with the burning soil. These hot winds are for the most part merely disagreeable; but cold winds are very often dangerous; in the North-Western States of America a cold wind, ushering in a violent snow-storm, caused the death of more than 300 people in January, 1873; and in many other localities, a cold wind bringing in a sudden fall of temperature through 40 or 50 degrees, is always a cause of grave anxiety. Our English "Blackthorn Winter" in April or May is only one, and a subdued instance of the ill-effects of such cold spells.

The presence of moisture in the air, by checking radiation from the ground by night, or during the winter, softens the rigour of the seasons, makes the summers less hot, the winters less cold. It is this that constitutes the difference between "insular" and "continental" climates; it is the want of the vapour-screen which causes "excessive" climates such as we read of